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SIR CHARLES LYELL

HIS PLACE IN GEOLOGICAL SCIENCE AND HIS CONTRIBUTIONS TO THE GEOLOGY OF NORTH AMERICA[1]

By Professor FRANK DAWSON ADAMS

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THERE are few periods more eventful or more interesting in geological history than the earlier half of the nineteenth century. While at the opening of the century Hutton had passed away and Werner was an old man whose work was well-nigh done, the great controversy between their followers, the Plutonists and the Neptunists, still raged on.

In the first half of the nineteenth century, however, geologists bent their attention more particularly to a close and intimate study of the structure of the earth's crust. It had already been recognized that there was some sort of succession of layers of mineral matter in the earth's crust; Werner had indeed introduced the term *geognosy* for the study of these. But in the period under consideration this succession was definitely established, and the formations (as Werner would call them) comprising it were grouped in their successive series and systems, succeeding one another in regular order, and each marked by its own peculiar organic remains, or "organic fossils" as they were then called.

The science of historical geology was thus brought to birth, and the recognition of the chronological value of fossils may be said to have done more to advance and consolidate the progress of geological knowledge than any discovery that was ever made.

One of the leaders in this great work was William Smith, usually known as the "Father of English Geology." His contributions are set forth chiefly in his great geological map of England and Wales and its

[1] An address delivered, at the request of the organizing committee, before the International Geological Congress at Washington, D. C., on July 25, 1933, in commemoration of the centenary of the publication of Lyell's "Principles of Geology" in 1833.

accompanying Memoir, which appeared in the year 1815, and in his "Strata Identified by Organized Fossils," which came from the press the following year.

Smith arranged the formations in their true order from the Killas (Lower Devonian, etc.) of Wales up to the Tertiary of the London Basin. This succession required, however, to be extended, filled out and subdivided in further detail. That portion of it below the Old Red Sandstone, the "interminable grauwake" as Murchison called it, was regarded as an inchoate jumble in which no order could be traced, while in the upper portion of the column, the great succession of the Tertiary rocks, awaited study and the discovery of some method by which it could be classified.

To this fascinating task a number of men, the immediate successors and most of them the contemporaries of William Smith, addressed themselves.

Among these men whose names have now a world-wide celebrity are Murchison, Sedgwick, Darwin, Forbes, Ramsay, Buckland, Hall, Phillips, Conybeare, Fitton and Webster. All of them were fellows of the Geological Society of London, a society which was founded in 1807 "to investigate the mineral structure of the earth," and during the first half of the nineteenth century this society was the meeting place for all those who were actively engaged in geological studies in England, its meetings were the forum for presentation, debate and discussion of all new geological observations and discoveries, and its Transactions became a veritable storehouse of the results of the most valuable original researches.

Charles Darwin was an enthusiastic member of the society at this time, and in a letter written from Lima and addressed to W. D. Fox in 1835, he says: "I am glad to hear you have some thoughts of beginning Geology. I hope you will; there is in it so much larger a field for thought than in the other branches of Natural History. Geology is a capital science to begin, as it requires nothing but a little reading, thinking and hammering."— a truly happy state of affairs which has now passed away under the accumulated burden of acquired knowledge; and in another letter written to Miss Buckley, Lyell's secretary, on the occasion of Lyell's death, he says of Lyell, "How completely he revolutionized geology; for I can remember something of pre-Lyellian days —I never forget that almost everything which I have done in science I owe to the study of his great works."

Into this brilliant group came the young lawyer, Charles Lyell, who, while studying at Oxford, had attended the lectures on geology delivered by Dean Buckland, then professor of geology at that seat of learning and at the height of his popularity, which lectures had interested him intensely

He was the eldest son of Charles Lyell, Senior, and was born at Kinnordy in central Forfarshire, where his father's estate was situated, on November 14th, 1797, and died in 1875 at the age of 78. The elder Lyell was a botanist of some renown, a man of cultivation and refinement, who was also known as a student of Dante. When his son was only a year old, Charles Lyell, Senior, took up his residence in England, at Lyndhurst in the New Forest.

The younger Lyell, after leaving school, went to Oxford, where in 1819 he graduated with second-class classical honors. He then studied law at Lincoln's Inn and Gray's Inn and went on circuit in 1827. He was moved to give up the study of law chiefly on account of the weakness of his eyes, a trouble which hampered him in his work throughout his entire life, but which was a less serious impediment to him in the new profession of geology which he adopted than it had been in that of the law which he was obliged to relinquish.

Lyell's first contribution to geological science was a paper which he read before the Geological Society of London in 1825, just fifteen years after the appearance of William Smith's epoch-making map, under the title, "On a recent Formation of Freshwater Limestone in Forfarshire and on some recent Deposits of Freshwater Marl," being a description of the deposits in a marl lake at Kinnordy in Forfarshire, the property of his father. Not long after he became one of the honorary secretaries of the Geological Society.

Having familiarized himself, in a general way at least, with the geology of Great Britain, Lyell proceeded to extend his knowledge by traveling in other countries.

In 1828 he joined Murchison in a visit to the continent of Europe, where, under the guidance of Constant Prevost, they made a study of the Tertiary deposits of the Paris basin, and later they saw the enormous succession of beds of limestone displayed in Italy, especially in the district about Syracuse in Sicily, made up of shells, many of them of species still living in the waters of the Mediterranean, which interested him greatly.

They also visited the extinct volcanoes of the Auvergne district as well as Vesuvius and Etna. The evidence of the elevation and subsidence of land, accompanying recent volcanic action, seen in the vicinity of Pozzuoli, made a deep impression on his mind.

Later he returned to Italy and France and visited many localities which are of especial interest to the student of geology.

He also traveled extensively in Germany, Austria, Denmark and Scandinavia. When in Bohemia, in company with Barrande, he studied the "Primordial

Succession" of that country and visited certain of Barrande's "Colonies." In the same year he went to Switzerland for the purpose of studying the action of ice as displayed in the Alpine Mountains.

In 1841–42, 1846, 1852 and again in 1853, he visited North America.

He was a great believer in the importance of travel in the education of a geologist. In a letter to Murchison written in 1829 he says, "We must preach up travelling, as Demosthenes did 'delivery,' as the first, second and third requisite for a modern geologist in the present adolescent state of the science."

The results of his geological observations in these various countries are set forth in an extended series of papers, most of which appeared in the *Journal* of the Geological Society of London.

The benefit which accrued to science from Lyell's extended travels lay not so much in these individual papers as in the wide range of the knowledge which he gained of the geological sequence in many widely separated areas of the earth's crust, and of the actual knowledge of the geological forces now at work on the earth's surface and of the effects which they were producing.

He did not, like Sedgwick, Murchison or Logan, add new chapters to geological history, but, as Ramsay once remarked to Geikie, "We collect data and Lyell teaches us to comprehend the meaning of them." He had a keen critical sense and a remarkably clear vision of great vistas in geological science—so much so that Darwin has stated as his opinion that "the Science of Geology is enormously indebted to Lyell—more so, I believe, than to any other man that ever lived."

It was this comprehensive grasp of the problems of geology which enabled him to write his great work entitled "Principles of Geology," whose appearance we commemorate to-day, and of which Geikie remarks that "of all the English writers of general treatises on geology, the first place must undoubtedly be assigned to Charles Lyell whose 'Principles of Geology' will always rank as one of the classics of geology and must form an early part of the reading of every man who would wish to make himself an accomplished geologist."

The full title of this great classic sets forth its scope; it reads, "Principles of Geology, being an attempt to explain the former changes of the Earth's Surface by reference to causes now in operation." The first edition appeared in three volumes, embracing in all 1,348 pages with accompanying maps, plates and illustrations. These three volumes appeared in succession—the first in 1830, the second two years later in 1832 and the third in 1833, just 100 years ago. The work went through twelve editions—the last of these appearing in 1875.

In this brief address it is possible merely to touch upon one or two of the outstanding problems discussed in this great classic. They are in a general way summarized in the opening pages of Volume 3, and I shall, so far as possible, employ Lyell's own words.

All naturalists, he says, who have carefully examined the arrangement of the mineral masses composing the earth's crust have recognized therein a great succession of former changes and sought for the causes of those changes. As the first theorists possessed but a scanty acquaintance with the present economy of the animate and inanimate worlds, and the vicissitudes to which these are subject, we find them in the situation of novices who attempt to read a history written in a foreign language, doubting about the meaning of the most ordinary terms, disputing, for example, whether a shell was really a shell, whether sand and pebbles were the result of aqueous trituration, whether stratification was the effect of successive deposition from water, and other questions which now appear to us so simple that we can hardly conceive them ever to have been the subject of controversy.

It appeared to them more philosophical to speculate on the possibilities of the past than patiently to explore the realities of the present. The habit of speculation produced a state of mind unfavorable in the highest degree to the reception of the evidence of those minute but incessant changes which every part of the earth is undergoing. It appeared as improbable to these early speculators of geology that the study of earthquakes should one day throw light on the origin of mountains, as it must to the first astronomers that the fall of an apple should assist in explaining the motions of the moon.

In an attempt to unravel the difficult questions presented to us, Lyell goes on to say, we shall adopt a different course, restricting ourselves to the known or possible operations of existing causes, feeling assured that we have not yet exhausted the resources which the study of the present course of nature may provide, and therefore that we are not authorized in the infancy of a science to recur to extraordinary agents. We shall endeavor to patiently unite the Gordian knot rather than attempt to cut it. In so doing we must consider the operation of aqueous and igneous forces, the geographical distribution of animals and plants, the successive extinction of species and so forth. These topics we regard as constituting the alphabet and grammar of geology, not that from them we expect to obtain a key to the interpretation of all geological phenomena, but because they form the groundwork from which we must rise to the contemplation of more general questions relating to the results which, in an indefinite lapse of ages, the exist-

ing causes of change may give rise. This is the doctrine of uniformitarianism with which Lyell's name will always be associated.

It has sometimes been objected that Lyell went too far in that he attributed all changes in the earth's crust to the slow, continuous and uniform action of the geologic agents, whereas catastrophic action does take place, and has been observed to do so even at the present time. This criticism, however, misses the point of Lyell's teaching. He recognized that in the regular course of nature great catastrophies do occur from time to time. But, as he says, we are authorized to regard them as part of the present order of nature, provided we do not imagine them to have been more frequent or general than we expect them to be in time to come. That is to say, the changes which have taken place, are taking place and will take place on the earth's crust go on with a general uniformity, there being here and there and now and then great landslides, earthquakes or volcanic explosions, through all the ages.

Lyell's "Principles" furnished a direct and immediate answer to Cuvier's "Discours sur les Revolutions de la Surface du Globe" which appeared in 1825, just before Lyell visited him in Paris when on his trip to the Continent with Murchison, and which presents the other side of the picture and represents views commonly held before Lyell's time.

Cuvier was one of the last of the great catastrophists and had been engaged in his classic studies on the paleontology of the Tertiary Succession of the Paris Basin. He had found evidence of the frequent elevation and subsidence of this great area, with the disappearance of old faunas and the appearance of new ones, and to explain these he invoked a succession of sudden and overwhelming catastrophies. These are his words in this connection (translated):

> The changes which resulted in the appearance of dry land in this region were not due to a more or less gradual and wide-spread subsidence of the waters. There were many sudden uprisings and many successive retreats, which resulted however in a final lowering of the general level. But it is very important to bear in mind that those repeated advances and retreats were not slow and gradual in character—on the contrary most of the catastrophies to which they gave rise were sudden, and this is especially easy to prove in the case of the last one, which by a double movement, consisting first of an inundation and then of a retreat of the waters, left our present continents essentially as we see them to-day.
>
> It left behind also in northern countries, the carcasses of the great quadrupeds which are found embedded in the ice and preserved down to the present day intact with their hair, hides and flesh. On the other hand, this perpetual frost did not previously occupy the areas where we now find it, for those animals could not live at so low a temperature. It was therefore at one and the same instant that these animals perished and that the glacial conditions came into existence.
>
> This change was sudden, instantaneous not gradual, and that which is so clearly the case in this last catastrophe is not less true of those which preceded it. The dislocation and overturning of the older strata show without any doubt that the causes which brought them into the posiiton which they now occupy, were sudden and violent; and in like manner testimony to the violence of the movements which influenced the waters is seen in the great masses of debris and rounded pebbles which in many localities are found intercalated between beds of solid rock.
>
> Life upon the earth in those times was often overtaken by these frightful occurrences. Living things without number were swept out of existence by catastrophies. Those inhabiting the dry lands were engulfed by deluges, others whose home was in the waters perished when the sea bottom suddenly became dry land; whole races were extinguished leaving mere traces of their existence, which are now difficult of recognition, even by the naturalist. The evidences of those great and terrible events are everywhere to be clearly seen by anyone who knows how to read the record of the rocks.[2]

It was to such opinions that Lyell's theory of uniformitarianism was opposed. His "Principles of Geology" gave the death blow to the great catastrophic school of geologists.

Another great contribution which Lyell made to the science of geology is set forth in the third volume of his "Principles"—namely, the classification of the succession of the Tertiary deposits on the basis of the proportion of recent species found fossil in each.

He states that he had already conceived this idea in 1828 when he visited Italy. He then found that Bonelli and other conchologists had been investigating the relative proportion of living species in the fossils of the Tertiary rocks of that country but had reached widely different results. In the following year, 1829, when he returned to Paris, he communicated his new views to Desnoyers and, learning from him that Dehayes had been working along the same line, at once visited this latter gentleman and arranged to secure his cooperation in this important work, which was thus carried forward to its successful conclusion.

This conclusion, however, had only been reached after much thought and investigation and after Lyell had many times been obliged to change his opinion owing to his discovery of new evidence—"I have frequently been led to reflect," he writes, "on the precept of Descartes that a philosopher should once in his life doubt everything that he had been taught."

Following his "Principles," Lyell wrote two works —the "Elements of Geology" and the "Student's Ele-

[2] "Discours sur les Revolutions de la Surface du Globe," M. le Baron G. Cuvier, 1826, pp. 8 and 9.

ments of Geology" which for many years remained the most important text-books of the science throughout the English-speaking world. The great life work of the author is again exemplified in them, by his treatment of the various systems in descending order, instead of the reverse, as in all modern text-books, thus proceeding from the known progressively further back into the unknown, from present conditions to those of the ever remoter past.

In 1841 Lyell was invited by Mr. Lowell to deliver the Lowell lectures in Boston that year. He made this the occasion for an extended visit to North America during the years 1841 and 1842 and gave an account of his experiences in a book entitled, "Travels in North America in the years 1841–42, with geological observations on the United States, Canada and Nova Scotia," which was published in 1845.

He paid a second visit to America in 1846 and described his travels in another book which bears the title, "A Second Visit to the United States of North America."

He visited North America again in 1852 and gave the Lowell lectures in Boston in that year, and returned a fourth time in 1853 to act as commissioner to the New York International Exhibition.

These books deal chiefly with incidents of travel and with the social and political conditions of the United States and Canada at that time. He was greatly interested in observing the development of society in these new countries, where conditions were as yet immature and often crude, but being a man of wide human sympathies he took a kindly and understanding interest in all that he saw and heard. He narrates many interesting incidents of American life of the times, which can not here be referred to further. Among other things he mentions the large number of classical or Old World names which had been adopted by various places which he and Lady Lyell, who accompanied him, visited on their tours. "In a short excursion of one month," he says, "we had been at Syracuse, Utica, Rome and Parma, had gone from Buffalo to Batavia and on the same day breakfasted at St. Helena and dined at Elba. We collected fossils at Moscow and traveled by Painted Post and Big Flats to Havana. After returning by Auburn to Albany, I was taken to Troy, a city of 20,000 inhabitants, that I might see a curious landslip which had just happened on Mount Olympus, the western side of the hill, together with a contiguous portion of Mount Ida having slid down into the Hudson and caused the death of several persons."

In his first book, however, he describes, at some length, a number of places of geological interest which he visited and refers with pleasure to meeting many of the leading geologists of North America, who took him to see sections which they had studied in detail and discussed with him the problems which they presented. These discussions, by bringing together, as they did, the experiences derived from the study of such problems in Europe and America, respectively, materially contributed to a true understanding of the same and assisted in establishing many valuable correlations.

While the description of the geological occurrences which he visited, as given in his first book, are more or less popular and adapted to the comprehension of the general reader, more detailed and technical descriptions of a number of the more important of them are presented in a series of papers which he contributed to the Geological Society of London and to *Silliman's Journal,* shortly after his return to England.

One of his first geological excursions in America was made with James Hall:

> On leaving Albany [he says] I determined so to plan my route to the Falls of Niagara so as to enable me to see by the way the entire succession of mineral groups from the Lowest Silurian up to the coal of Pennsylvania. Mr. James Hall, to whose hands the N.W. division of the Geological Survey of New York had been confided, kindly offered himself as my guide. Taking the railway to Schenectady and along the Mohawk valley we first stopped at Little Falls where we examined the gneiss and the lowest Silurian sandstone resting upon it. We then pursued our journey along the line of the Erie Canal and the Mohawk River, stopping here and there to examine quarries of limestone and making a short detour through the beautiful valley at Cedarville in Herkimer County, where there is a fine section of the strata. Afterwards we explored the picturesque ravine through which the Genesee flows at Rochester. The excavations also made for the Grand Canal at Lockport afforded us a fine opportunity of seeing these older fossiliferous rocks laid open to view. . . . In the course of this short tour [he continues] I became convinced that we must turn to the New World if we wish to see in perfection the oldest monuments of the earth's history, so far at least as relates to its earliest inhabitants, certainly in no other country are these ancient strata developed on a grander scale or more plentifully charged with fossils.

At Troy he visited Eaton, and when at New Haven he saw, in company with the two Sillimans, East and West rock, which he compares with the Salisbury Crags at Edinburgh. Later, in company with H. D. Rogers, he visited the anthracite region of Pennsylvania.

In discussing the origin and structure of the Appalachian Mountain Chain he says:

> According to the theory of the Professors Rogers, these wave-like flexures are to be explained by supposing the strata, when in a plastic state, to have rested on a widely

extended surface of fluid lava and elastic vapours and gases. The billowy movement of this subterranean sea of melted matter imparted its undulations to the elastic overlying crust, which was enabled to retain the new shapes thus given to it by the consolidation of the liquid matter injected into fissures. For my own part [he goes on] I can not imagine any real connection between the great parallel undulations of the rocks and the waves of a subjacent ocean of liquid matter.

It is interesting to note that on the 25th of April, 1842, Lyell attended at Boston the third annual meeting of the Association of American Geologists, a body which in 1847 developed into the American Association for the Advancement of Science, and which may be considered as the predecessor of the Geological Society of America, which came into being in 1888. Among those who were present at this meeting he mentions Hitchcock, the two Rogers, Vanuxem, Emmons, Hall, Beck, Jackson, Locke, the two Sillimans, Bailey, Dana, Hayes and others; and he states that the structure of the Alleghany Hills and of the coal fields of America, the origin of coral reefs, the glacial theory, the effects of icebergs, the nature of the footmarks in the red sandstone of the Connecticut Valley and other subjects were debated upon during the week in an animated but most amicable style.

When in America Lyell also made a study of the Tertiary succession in Virginia, the Carolinas and Georgia, as well as of the question of the recession of Niagara Falls as a measure of geological time.

He was also much interested in the wide-spread evidence of glaciation in post-Tertiary times. Like so many other geologists of his day, he believed this to be due to floating ice.

When visiting Amherst College Hitchcock took him to several ridges of "drift" in this vicinity. These, he says are precisely the same as those in Scotland and Northern Europe. "They have been called Moraines by some geologists, but if we call in the agency of ice, as I am well disposed to do, we must attribute their accumulation to the melting of icebergs charged with fragments of gravel and rock rather than to glaciers. Professor Hitchock has in fact," he says, "called them iceberg moraines."

On his first visit to America Lyell spent a month or more in Nova Scotia, where, in company with Dawson, who later became principal of McGill University, he made a study of the succession of the Carboniferous rocks in that province and especially of the remarkably fine sections of the Coal Measures displayed on the shores of the Bay of Fundy and known as the Joggins Section.

"This subterranean forest," he writes, "exceeds in extent and quantity of timber all that have been discovered in Europe together."

Perhaps I can not do better in closing this address than quote some words of Dawson concerning Lyell and the place which he filled in geological science—taken from Dawson's last published work, entitled "Fifty Years' Work in Canada":

In 1841 [Dawson says] I met with two great geologists, whose friendship followed and assisted me through the earlier years of my career. These were—Sir Charles Lyell, who more than any other man gave form to modern geological science; and Sir William Logan, who gave the first great impulse to the systematic geology of the older rocks of the North American continent, and originated the Geological Survey of Canada. To other men who have passed away, and whose friendship I have enjoyed, I owe much; but to Lyell and Logan I owe most.

The benefits rendered by Lyell to American geology in connection with his several visits to this continent, it would not be easy to overestimate. At the time of his first visit, few English geologists had seen those great breadths of the older, and of the more recent formations, by which this continent is distinguished, or had had the means of realizing for themselves the resemblances and differences of the formation on the opposite sides of the Atlantic; and the American and British workers in these subjects were little known to each other. The visits of Sir Charles Lyell did much to remedy all this. His own mind was filled with those grander aspects of geological phenomena which appear in America. He brought into correspondence with each other such workers in science as his intuitive tact perceived to be suited to give mutual aid.

In these American researches, the great gifts of the man were brought out in a light somewhat different from that in which they appear in his general works. The main distinction between Lyell and most of his contemporaries was his eminence as a thinker, whether in inductive or deductive reasoning. Like most of the English geologists of his time, he had received less training in the characters of minerals and rocks than that which the more severe schools of science exacted, and his imperfect vision was a great hindrance to field work, and sometimes even a source of personal danger; but when facts, however complex, were once obtained, they grouped themselves in his mind in their natural relations with an unfailing certainty, while their connections with all the other parts of his vast stores of knowledge, and the general conclusions deducible from them, came out with a degree of clearness always beautiful, and often even startling.

A feature of his mental character was the readiness with which he accepted new conclusions, and relinquished without regret views which he might have long held, when he perceived them to be shaken or untenable. He seemed wholly free from that common failing of men of science which causes them to cling with such tenacity to opinions once formed, even in the face of the strongest evidence. This quality eminently fitted him to be the expositor of a rapidly advancing science, and also to be the patron and helper of younger and less eminent men, and was

connected with that warm and eager interest which he ever felt in the progress of knowledge, and with the deference with which he received new facts and suggestions from any quarter.

The qualities, apparent in his connection with American geology, were equally valuable in his relations to science in its general aspects. A man so gifted, fortunate in his genius, his education, his outward circumstances, and in his appearance on the stage at a time when geology had gathered in some of its great harvest of facts, and was waiting for a master-mind to arrange them, had a great opportunity, which Lyell had the energy and ability to seize. He was thus able to become a guiding mind among his contemporaries in geological theory, and to hold his pre-eminence down to the end of his life, and through all the great changes which occurred in the rapid development of the science.

Such was the man whose life and works we commemorate this evening.

SCIENTIFIC EVENTS

THE ROSS INSTITUTE AND THE LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

THE *British Medical Journal* states that a printed memorandum on the proposed amalgamation of the Ross Institute and Hospital for Tropical Diseases with the London School of Hygiene and Tropical Medicine has been issued by Sir Charles McLeod, chairman of the institute. On the death of Sir Ronald Ross he considered it his duty to make a special inquiry into the organization of the institute, so as to ensure that it would be a worthy memorial to a great man, but before that could be completed there came a proposal for amalgamation with the London School of Hygiene and Tropical Medicine. The question was first raised by the Goldsmiths' Company, which, before giving a grant to the institute, asked for an assurance from the honorary treasurer, Lord Queenborough, that there was no overlapping of the activities of the school and the institute. At an informal meeting between Sir Austen Chamberlain, the late Sir Walter Fletcher, members of the board of management of the school, and Lord Queenborough and Sir Charles McLeod, representing the institute, it became clear that overlapping occurred widely in the field from which support for both bodies was obtained, and that possibly there was overlapping in other activities. Since that date there have been a number of discussions. Early in their course a large measure of agreement was found, both on fundamentals and on details, and an assurance given that in the event of amalgamation the school would accord the work of the institute its fullest support, both for its own sake and as a memorial to Sir Ronald Ross.

As a result of these discussions, the Board of Management of the School and the Executive Committee of the Ross Institute have decided on the desirability of the amalgamation; and I am issuing this memorandum to explain to members of the institute the reasons which have induced me to come to the conclusion that amalgamation should take place, how it will affect the objects for which the Ross Institute was founded, and something of the school and its associated hospital with which amalgamation is proposed.

Sir Charles McLeod recalls particularly that in the reorganization which led to the creation in London of a great school of hygiene that would be of value not only to Britain and the British Empire, but to every part of the temperate and tropical zones, the long association of the London School of Tropical Medicine and the Seamen's Hospital Society was preserved by a special agreement, which provided that research and clinical instruction should be carried on in their Hospital for Tropical Diseases in Endsleigh Gardens, a few minutes' walk from the school. Turning to the origin of the Ross Institute, he describes how, in addition to being a memorial to Sir Ronald Ross, the fundamental idea was again work for the benefit of mankind. Although the histories of the London School of Hygiene and Tropical Medicine and the Ross Institute have been different, and although each has been developed on somewhat different lines, their fundamental objects, he says, have been identical, and their spheres of work are found to be complementary.

INTERNATIONAL CONFERENCE ON CHEMICAL RECORDS

Industrial and Engineering Chemistry publishes a note by Dr. Austin M. Patterson on a 20-page pamphlet entitled "Recommendations of the Experts Assembled in Paris, September 19 to 20, 1932, by the Office International de Chimie." The office was created by international diplomatic convenant and began to function in 1932. Its headquarters are in Paris. It proposes to study the organization of chemical records, to promote cooperation between the centers of such records in the different countries and to facilitate exchanges and loans.

The delegates present at this first conference were: F. Donker Duyvis, Netherlands; P. Dutoit, Switzerland; F. Haber, Germany; E. Hauser, Spain; C. Marie, France; N. Parravano, Italy; G. Peny, Belgium; J. C. Philips, Great Britain. J. F. Norris,

delegate from the United States, was unable to attend. Representatives of organizations present were: J. Gérard, International Union of Chemistry; D. Secrétan, International Institute of Intellectual Cooperation; P. H. Chase and G. Riedberg, International Chamber of Commerce.

The conference voted that, in view of the great importance and variety of the literature and other records, it is highly desirable that the office establish permanent coordination and cooperation among the various centers over the world, and that it strive to make the accumulated documents available to searchers.

The field is divided into pure chemistry and applied chemistry (plant and laboratory, combustibles, inorganic industries, organic industries, agronomy and agricultural industries). Among the "documents" are included not only books, pamphlets, periodicals, charts, patents and manuscripts, but laboratory and plant products, equipment, models, photographs, films, disks, etc.

The Office International de Chimie has, according to the experts, three principal tasks: (1) to render accessible the documents already existing; (2) to assist in improving their production, indexing, preservation and distribution, and (3) to assure coordination between chemistry and other fields in this matter. Under (1), various international indexes and collections need to be established. Under (2), the most appropriate technics need to be studied and a knowledge of them diffused. Under (3), the office will represent chemistry in a general coordination and improvement of the records of scientific knowledge as a whole and in avoiding overlapping the sciences. Other topics considered were the safeguarding of the rights of authors and publishers and the lowering of the cost of scientific publications.

The office is engaged in the preparation of an international index of centers of chemical records which will give exact information as to the nature of each center and the services which it renders. It will be published in book form.

COMMITTEES OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

AT the August meeting of the Board of Directors of the American Institute of Electrical Engineers, President Whitehead announced the committee appointments for the administrative year beginning August 1, 1933. The chairmen of the general committees are as follows:

Executive: J. B. Whitehead (president of the institute), dean of the faculty of engineering, the Johns Hopkins University.

Board of Examiners: H. Goodwin, Jr., consulting engineer, Philadelphia.

Code of Principles of Professional Conduct: C. E. Stephens, vice-president, Westinghouse Electric and Manufacturing Company, New York.

Columbia University Scholarships: W. I. Slichter, professor of electrical engineering, Columbia University.

Constitution and By-laws: W. S. Gorsuch, engineer of economics, Interborough Rapid Transit Company, New York.

Coordination of Institute Activities: E. B. Meyer, vice-president, United Engineers and Constructors, Incorporated, Newark.

Economic Status of the Engineer: C. O. Bickelhaupt, assistant vice-president, American Telephone and Telegraph Company, New York.

Edison Medal: C. E. Stephens, vice-president, Westinghouse Electric and Manufacturing Company, New York.

Finance: E. B. Meyer, vice-president, United Engineers and Constructors, Incorporated, Newark.

Headquarters: W. S. Gorsuch, engineer of economics, Interborough Rapid Transit Company, New York.

Iwadare Foundation: F. B. Jewett, vice-president, American Telephone and Telegraph Company; president, Bell Telephone Laboratories, New York.

Lamme Medal: C. E. Skinner, Wilkinsburg, Pennsylvania.

Legislation Affecting the Engineering Profession: W. I. Slichter, professor of electrical engineering, Columbia University.

Membership: Everett S. Lee, engineer in charge, General Engineering Laboratory, General Electric Company, Schenectady, New York.

Advisory Committee to New York Museum of Science and Industry: John P. Jackson, manager, Department of Personnel and Statistics, Manhattan District, New York Edison Company, New York.

Popular Science Award: Harold Pender, dean, Moore School of Electrical Engineering, University of Pennsylvania.

Award of Institute Prizes: R. N. Conwell, transmission and substation engineer, Public Service Electric and Gas Company, Newark.

Publication: E. B. Meyer, vice-president, United Engineers and Constructors, Incorporated, Newark.

Public Policy: H. P. Charlesworth, assistant chief engineer, American Telephone and Telegraph Company, New York.

Safety Codes: F. V. Magalhaes, General Electric Company, Lynn, Mass.

Sections: I. Melville Stein, director of research, Leeds and Northrup Company, Philadelphia.

Standards: A. M. MacCutcheon, engineering vice-president, Reliance Electric and Engineering Company, Cleveland.

Student Branches: L. A. Doggett, professor of electrical engineering, Pennsylvania State College.

Technical Program: R. N. Conwell, transmission and substation engineer, Public Service Electric and Gas Company, Newark.

Transfers: J. Allen Johnson, chief electrical engineer, Buffalo, Niagara and Eastern Power Corporation.

THE SILLIMAN LECTURES AT YALE UNIVERSITY

DR. HANS SPEMANN, distinguished experimental zoologist of the University of Freiburg, will give a course of lectures under the Hepsa Ely Silliman Foundation at Yale University during October, 1933. The title of the course is: "Embryonic Development and Induction." The subtitles for the seven lectures of the course are as follows:

Early experiments and fundamental concepts of experimental embryology.

Factors involved in the development of a compound organ (the vertebrate eye).

On the development of the amphibian egg, its pattern and potencies up to the early gastrula stage.

Experimental induction of a secondary embryo and the rôle of induction in normal development.

Time-correlation in the induction system; regional determination; the embryonic field.

The means of induction; its character as a stimulating factor; the tendency of the organizer to form a whole.

The application of the facts presented; experiments on other forms; conceptions and theories.

The lectures will be given in Strathcona Hall, beginning on Wednesday, October 11, at 4:15 P. M. and at the same hour and place on October 13, 16, 18, 20, 23 and 25.

THE ORGANIZATION MEETING OF THE SOCIETY FOR RESEARCH ON METEORITES

THE organization meeting of the Society for Research on Meteorites was held, through the courtesy of Director S. C. Simms and Dr. O. C. Farrington, at the Field Museum of Natural History, in Chicago, on August 21 and 22.

Fifteen of the approximately fifty charter members of the society were present at the meeting, which was marked by unusual interest and great enthusiasm. A constitution and a set of by-laws were adopted for the society, a number of addresses and scientific papers were delivered, and several special committees were appointed, in the course of the various sessions of the meeting.

The following officers and councilors were elected for the biennium 1933–35:

Honorary President: Dr. Oliver C. Farrington, curator of geology, Field Museum of Natural History, Chicago.

President: Dr. Frederick C. Leonard, chairman, department of astronomy, University of California at Los Angeles.

First Vice-president: Dr. C. C. Wylie, department of mathematics and astronomy, University of Iowa.

Second Vice-president: Dr. W. F. Foshag, curator of mineralogy, U. S. National Museum, Washington, D. C.

Secretary-Treasurer: Professor H. H. Nininger, director, Nininger Laboratory, and curator of meteorites, Colorado Museum of Natural History, Denver.

Councilors: Mr. L. F. Brady, curator of geology, Museum of Northern Arizona, Flagstaff, and Mesa Ranch School; Dr. G. M. Butler, dean of the college of mines, University of Arizona; Professor Raymond E. Crilley, department of mathematics, Iowa Wesleyan College, Mt. Pleasant; Dr. F. R. Moulton, 6227 Woodlawn Ave., Chicago; Mr. Henry W. Nichols, associate curator of geology, Field Museum of Natural History, Chicago; Dr. Walter F. Whitney, department of astronomy, Pomona College, Claremont, California.

FREDERICK C. LEONARD,
President
H. H. NININGER,
Secretary

THE CHICAGO MEETING OF THE AMERICAN PSYCHOLOGICAL ASSOCIATION

THE 1933 meeting of the American Psychological Association will be held at the University of Chicago from September 7 to 13, under the presidency of Professor L. L. Thurstone, of the University of Chicago. The sections in which the association will meet and the presiding officers are as follows:

THURSDAY, SEPTEMBER 7

Physiological Psychology: Professor Joseph Peterson, professor of psychology, George Peabody College for Teachers.

Personality: Dr. Leonard Carmichael, professor of psychology, Brown University.

Psychology of Reading: Professor Edward L. Thorndike, professor of educational psychology, Teachers College, Columbia University.

Research of Films: Professor Herbert Woodrow, professor of psychology, University of Illinois.

FRIDAY, SEPTEMBER 8

Human Learning: Professor Harvey Carr, professor of psychology, University of Chicago.

Esthetics: Dr. Harold E. Burtt, professor of psychology, Ohio State University.

Child Psychology: Professor Carl E. Seashore, professor of psychology, State University of Iowa.

Psychophysics: Professor Henry E. Garrett, assistant professor of psychology, Columbia University.

Psychological Corporation Meeting: President Walter Dill Scott, Northwestern University.

SATURDAY, SEPTEMBER 9

Sensation and Perception: Dr. Karl M. Dallenbach, professor of psychology, Cornell University.

Child Psychology: Dr. John Edward Anderson, professor of psychology, University of Minnesota.

Memory: Professor Walter R. Miles, professor of psychology, Yale University.

MONDAY, SEPTEMBER 11

Animal Psychology: Professor Robert M. Yerkes, professor of psychobiology, Yale University.

Mental Tests: Professor Florence L. Goodenough, professor of research, University of Minnesota.

Galvanometric Studies: Professor A. T. Poffenberger, professor of psychology, Columbia University.

Instructional Films: Dr. Franklin Fearing, associate professor of psychology, Northwestern University.

TUESDAY, SEPTEMBER 12

Social Psychology: Professor Walter B. Pillsbury, professor of psychology, University of Michigan.

Animal Psychology: Dr. Karl S. Lashley, professor of psychology, University of Chicago.

Clinical Psychology: Dr. Edgar A. Doll, director of research, The Training School, Vineland, New Jersey.

WEDNESDAY, SEPTEMBER 13

Industrial Psychology: President Walter Dill Scott, Northwestern University.

Animal Psychology: Professor John F. Dashiell, professor of psychology, University of North Carolina.

Abnormal Psychology: Professor Edward S. Robinson, professor of psychology, Yale University.

SCIENTIFIC NOTES AND NEWS

PROFESSOR ALBERT EINSTEIN has been elected a foreign associate of the Paris Academy of Sciences to fill the place vacant by the death of Professor Albert A. Michelson.

THE Conné Medal has been presented by the Chemists' Club of New York to Dr. Henry D. Dakin, editor of the *Journal of Biological Chemistry,* in recognition of his work on antiseptic solutions. The first award was made last year to Dr. John J. Abel, professor emeritus of pharmacology, the Johns Hopkins University School of Medicine.

AMONG those on whom the doctorate of laws will be conferred on the occasion of the celebration of the three hundred and fiftieth anniversary of the University of Edinburgh on October 28 will be Lord Rayleigh, emeritus professor of physics at the Imperial College of Science and foreign secretary of the Royal Society; Sir Edward Albert Sharpey-Schafer, retiring professor of physiology at the University of Edinburgh, and Sir James Colquhoun Irvine, principal of the University of St. Andrews, formerly professor of chemistry at the University of Glasgow.

DR. GEORGE BARGER, professor of medical chemistry at the University of Edinburgh, will receive the honorary degree of LL.D. from the University of Michigan on September 25.

THE Royal Numismatic Society, London, has awarded its medal to Professor Kurt Regling, director of the cabinet of coins at the Berlin State Museum.

DR. ALBERT PETER, professor of botany at the University at Göttingen, celebrated his eightieth birthday on August 21.

DR. BERNARD V. CHRISTENSEN, Ph.D., head of the department of pharmacognosy and pharmacology, University of Florida, has been appointed director of the school of pharmacy. The college of pharmacy was recently classified as a school and placed under the College of Arts and Sciences.

DR. HARRY B. WEISER, since 1919 professor of chemistry at Rice Institute, has been appointed dean.

DR. EBEN J. CAREY, director of the department of anatomy, Marquette University School of Medicine, Milwaukee, has been appointed dean to succeed Dr. Bernard F. McGrath, who resigned recently because of ill health.

PROFESSOR S. C. OGBURN, JR., formerly head of the department of chemical engineering at Bucknell University, Lewisburg, Pennsylvania, has been appointed chairman of the division of engineering at that institution. Dr. Robert C. Kintner, formerly of the department of chemical engineering of the Ohio State University, has become assistant professor of chemical engineering.

DR. J. L. MCELROY, superintendent of the hospital division of the Medical College of Virginia since 1929, has resigned to become director of the American Hospital, Paris, France; Dr. Lewis E. Jarrett, senior assistant superintendent of the hospital division, has been promoted to succeed Dr. McElroy. Promotions for the session 1933–34 include: Dr. W. R. Bond, from associate professor to professor of physiology; Dr. H. B. Haag, from associate professor to professor of pharmacology; Dr. R. H. Courtney, from assistant professor to associate professor of ophthalmology; Dr. Wyndham B. Blanton, from associate professor to professor of the history of medicine.

IT is announced in *Nature* that the following awards, among others, for the year 1933–1934 have been made by the Salters' Institute of Industrial Chemistry. Fellowships renewed to: S. C. Britton, Pembroke College, Cambridge, E. H. T. Hoblyn, Imperial College of Science and Technology, G. Pearce, University of Birmingham, and P. Chisholm Young, Trinity College, Cambridge. Fellowships awarded to: N. S. Kelland, St. John's College, Oxford, J. D. Rose, Jesus College, Oxford, F. C. Storrs, Chelsea Polytechnic and University College, London, C. W. Woolgar, King's College, London. The Salters' Institute has also awarded one hundred and ten grants-in-aid to young men and women employed in chemical works, to facilitate their further studies.

RAFAEL MENENDEZ RAMOS, an authority on sugar cane technology, has been appointed commissioner of agriculture and commerce for the island of Puerto Rico.

DR. MORTIMER E. COOLEY, dean emeritus of the College of Engineering in the University of Michigan, has been appointed state engineer under the Public Works Administration of the National Recovery program. Dr. James B. Edmonson, dean of the school of education, is director of the local NRA efforts.

MADEMOISELLE THÉRÈSE FRÉMONT, investigator in plant pathology in the Institut Pasteur, Lille, France, is spending the year at Riverside, California, in the laboratory of plant physiology of the Citrus Experiment Station of the University of California, where she will investigate certain problems of the mycorrhiza of citrus roots in cooperation with Professor H. S. Reed. Mlle. Frémont holds a traveling fellowship awarded by l'Institut Agronomique and a grant from la Caisse National des Sciences.

FATHER BERNARD F. DOUCETTE, S.J., of Manila Observatory, Manila, P. I., recently spent two weeks at the Scripps Institution of Oceanography of the University of California with Dr. G. F. McEwen, professor of physical oceanography.

DR. C. H. EDMONDSON, professor of zoology at the University of Hawaii, Honolulu, is visiting the United States.

DR. ALBERT W. C. T. HERRE, curator of the Zoological Museum, Stanford University, sails on September 11 for Yap, in pursuance of his studies of the geographical distribution of fishes in the tropical Pacific. The Pelews will next be visited, and further explorations made in the Philippines. Two or three months will be spent at Ling Nan University, Canton, in continuation of his investigations of the fishes of southeastern China. The return trip will be made *via* Singapore, Colombo, Mombasa, Zanzibar, Durban, Cape Town, Buenos Ayres, Rio de Janeiro and the Panama Canal.

DR. RICHARD THURNWALD, professor of ethnology at Berlin, has accepted an invitation from the Australian National Research Council, Sydney, to undertake a scientific expedition to New Guinea and the Solomon Islands.

DR. G. VAN ITERSON, professor of technical botany in the Technical University of Delft, gave on July 18 an illustrated demonstration lecture on liquid crystals before the newly formed California-at-Los-Angeles chapter of the Society of the Sigma Xi.

THE first American Congress of Radiology, organized in connection with the radiological exhibit at the Century of Progress Exposition, will be held in Chicago on September 25. Dr. George E. Pfahler, of Philadelphia, is chairman of the scientific program committee. Four organizations will take part, the American Roentgen Ray Society, the Radiological Society of North America, the American Radium Society and the American College of Radiology. One section of the congress will be devoted to roentgenological studies of tuberculosis, another to the study of bone tumors, a third to cancer of the mouth and skin and a fourth to urology and gynecology. Dr. Byrl R. Kirklin, of the Mayo Clinic, is chairman of a committee which is arranging an extensive scientific exhibit, and the leading manufacturers of x-ray equipment in America and Europe will show their appliances.

A SERIES of lectures on industrial chemistry and chemical engineering will be presented by specialists of the Mellon Institute of Industrial Research during 1933–34, on alternate Thursdays, at 11:30 A. M., throughout both semesters in the fellows' room of the institute. These discourses will be open to all students of industrial chemistry and chemical engineering in the University of Pittsburgh, as well as to the institute's members. The speakers are: October 5, Dr. E. R. Weidlein, "Chemical Engineering To-day and To-morrow"; October 19, Dr. H. J. Rose, "Solid Fuels"; November 2, Dr. A. P. Thompson, "Electric Furnace Products"; November 16, Dr. A. W. Coffman, "Corrosion-Resistant Materials"; December 7, Dr. W. W. Duecker, "Sulfur"; January 4, Dr. E. W. Reid, "Solvents"; January 18, Dr. P. B. Davidson, "Paper"; February 15, Mr. C. F. Goldthwait, "Textiles"; March 1, Dr. A. W. Harvey, "Cottonseed Products"; March 15, Dr. H. K. Salzberg, "Dairy Products"; March 29, Dr. J. J. Enright, "Bacteriology, Chemistry, and Public Health"; April 12, Dr. G. D. Beal, "Pharmaceuticals"; April 26, Dr. L. H. Cretcher, "Synthetic Medicinals."

THE Council of the Biological Society of Washington has reissued all the various parts of its *Proceedings* formerly out of print, and can now supply complete sets of volumes 1 to 46, 1881 to 1933, and can also supply whatever parts may be needed to complete partial sets now in the libraries of individuals or institutions. Among the items again available is the formerly very rare Volume 3, July 1, 1884, to February 6, 1886, now lacking from a considerable number of otherwise complete sets. This volume contains (pages 35 to 105, inclusive) the well-known work by Dr. G. Brown Goode entitled "The Beginnings of Natural History in America," the continuous demand for which contributed to the speedy exhaustion of the original edition. Lists of desiderata or requests

for information should be sent to the society's corresponding secretary, J. S. Wade, U. S. Bureau of Entomology, Washington, D. C.

THE first number of the newly named quarterly, *California Journal of Mines and Geology,* hitherto known as *Mining in California,* continues the increased attention to geology that has characterized its issues for two years past. The geology and the gold deposits of the mountainous Redding-Weaverville district, adjoining the northern end of the Great Valley Plain, are treated by N. E. A. Hinds, of the University of California at Berkeley, and C. A. Averill, mining engineer; the economic geology of Del Norte County, in the extreme northwestern corner of the state, is discussed by J. H. Maxson, of the California Institute of Technology at Pasadena; and a general description of the lakes of California is contributed by W. M. Davis, now associated with the same institute. All the articles are well illustrated. Geological visitors to California should know that, when they ferry across the bay and land at the Ferry Building on the San Francisco water-front, the State Division of Mines, by which the above-named journal is published, maintains on the third floor of that building a large collection of California minerals and a good library on geology and mining, open to the public.

ASSOCIATED with a deposit of mammoth bones found near Dent, Weld County, Colorado, two artifacts of the spear-head Folsom type have been discovered, the first by Father Bilgery, of Regis College, Denver, the second by Mr. B. F. Howarter, of the Colorado Museum of Natural History. The association is such as to indicate that the artifacts belong to the same period as the mammoths. An account of these finds, with illustrations, has been published by the Colorado Museum of Natural History; it is written by the director, J. D. Figgins.

WILD-LIFE management, as worked out by the School of Forestry and Conservation, University of Michigan, at Williamston, Michigan, in cooperation with other state and federal organizations, is illustrated at the Century of Progress Exposition as a part of the exhibit of the Izaak Walton League, of which S. B. Locke is conservation director. It consists of a diorama which illustrates farm land being managed for wild life. Several pheasants, including a family of young, are shown in the foreground, as are song birds and bobwhite quail. These are built up in wax and painted in natural colors. Food and cover patches and evergreen and shrub plantings are shown along the banks of a stream, while in the background are pictured the farm buildings, growing crops and the woods.

Nature writes: "Dungeness Promontory, famous amongst bird-lovers as the last refuge of the Kentish plover and the home of the stone-curlew and many other interesting shore-birds, is the only remaining natural and undisturbed area of any size on the south-east coast of Great Britain. A year or two ago, the key position of the area was threatened by the building contractor, and it was saved by the sacrifice of Mr. R. B. Burrowes, a retired teacher, formerly in the Electrical Department of Liverpool Technical College. Mr. Burrowes obtained an option upon the site at a cost of £5,585, which meant the selling or mortgaging of the whole of his possessions. The Committee of the Dungeness Preservation Fund is anxious to refund at least £1,740 of this amount, so that the donor may regain possession of certain bonds and securities lodged by him at his bank as security for a loan, without which he could not have made the original advance. He will still be out of pocket to the extent of £3,845, but he lives on a slender pension of £138 a year, gratified that his sacrifice has saved a valuable corner of England for the future. Any contribution towards the special sum now being raised will be gratefully received by the Manager, Lloyds Bank, Canterbury."

A CORRESPONDENT of the London *Times* reports from Rome that a first experiment in the establishment of sanctuaries for birds which are useful to agriculture is to be made in the National Park of Stra, near Padua. The scheme originated with the National Council of Research and its execution has been entrusted to the Zoological Institute of the University of Bologna, which has specialized in ornithological studies. The object of the scheme is twofold —to carry out a number of researches which are expected to yield biological results, and to preserve from destruction birds useful for agriculture. The Park at Stra, where the first sanctuary is to be established, has an area of about 50 acres and is well wooded. In order to encourage breeding 250 artificial nests, 30 feeding-boxes and 50 special nests are, it is said, to be placed in the grounds.

WHAT is believed to be the most complete recreation map of the United States ever prepared has been issued by the Office of National Parks, Buildings and Reservations of the Department of the Interior, and is available for free distribution. Arno B. Cammerer, director of the bureau, under whose supervision the map was prepared, states that it shows more than a thousand federal and state reservations of interest to the traveling public, and the main traveled highways of the United States. In addition to the superscenic regions that constitute the twenty-three national parks of the nation, the new map shows the location of all the state parks in the country, practically all the national forests, the most important Indian reservations, the national military parks, the national monuments, and state forests, monuments and

picnic grounds. On the back of the map are brief descriptions of all the places shown except the national forests and the Indian reservations. The Federal Reservations are listed under the executive departments having jurisdiction over them, and the other reservations are grouped according to states.

DISCUSSION

THE CHEMICAL NATURE OF ENZYMES

ENZYMES are regarded as specific catalysts of biological origin and of high molecular weight. Willstätter[1] pronounced the view that they consist of a carrier, colloidal in nature, and of one or several chemically active groups. This hypothesis has been widely accepted, as it accounts both for the physicochemical and the chemical behavior of the enzymes. The colloidal carrier determines the stability and the magnitude of catalytic activity of the active groups, while the nature of the active groups is responsible for the specificity of the enzymes.

This view is supported by observations on enzyme-like substances of known structure. Pure oxyhemoglobin is known to possess a marked peroxidase action[2] and a very insignificant catalase action[3] at the same time. Hemin, on the other hand, has only a slight peroxidase effect, but a very pronounced catalase activity. Mesohemin, formed by introduction of two hydrogen atoms into hemin, displays no catalase action at all, but is a strong peroxidase. Thus, a small change in the nature of the active group, such as the introduction of two hydrogen atoms, produces great qualitative changes in enzymatic specificity.

On the other hand, a change in the nature of the colloidal carrier produces a quantitative rather than a qualitative change in activity. In the case of purest oxy-hemoglobin crystals from different species,[4] demonstrated quantitative differences in the peroxidase action of these substances, which are composed of identical hemin, but different globins.

The chemical character of the active groups in natural catalase and peroxidase has been cleared up in recent years. Zeile and Hellstrøm[5] have shown by photospectrometric measurements on highly purified enzyme preparations that an iron-porphyrin complex has to be regarded as the active group of liver catalase and of pumpkin catalase. Similarly, Kuhn, Hand and Florkin[6] demonstrated the proportionalism between the content of porphyrin-bound iron and peroxidase activity in horse-radish preparations. Even the most highly purified preparations of peroxidase (20,000 times from raw horse-radish), contain only 0.1 per cent. of porphyrin. One can see from this that enzymes occur in Nature in very great dilution only, but are extremely active as catalysts. Thus it appears that the chemical nature of the colloidal carrier is mainly responsible for the great quantitative differences in activity of the porphyrin-iron group which obtain between hemoglobin and its derivatives on one hand and the naturally occurring catalases and peroxidases on the other.

The colloidal carrier of an enzyme can be altered in its composition, according to Willstätter, Graser and Kuhn's observations on yeast saccharase,[7] either by choosing a different variety of yeast or by changing the procedure of purification, sometimes with and sometimes without significant change in enzyme activity. The same principle applies to some of the highly purified preparations obtained in the form of crystallized proteins, namely, the crystalline urease of Sumner[8] and the crystalline pepsin of Northrop.[9] Trypsin digestion of the crystalline protein of urease takes place without significant change in urease activity.[10] In the case of crystalline pepsin, it has been shown by Dyckerhoff and Tewes[11] and in our laboratory[12] that the protein which carries the peptic activity can be changed arbitrarily by the adsorption of the active component on crystalline plant proteins, leaving the original protein carrier without activity.

These crystalline enzyme preparations should be regarded, then, as adsorption compounds of the true enzymatic component plus crystalline protein to which they have a special affinity. The finding of crystalline protein-enzyme compounds may lead to the concept that enzymes are merely proteins, and thus cause investigators to disregard enzyme specificity which can only be explained by the existence of highly specialized active groups.

The researches on catalase and peroxidase have shown that their active groups are non-protein in character. The way is thus cleared to investigate the nature of the enzymatically active groups of other

[1] R. Willstätter, *Ber.*, 55: 3601, 1922.
[2] R. Kuhn and L. Brann, *Ber.*, 59: 2370, 1926.
[3] F. Haurowitz, *Z. physiol. Chem.*, 198: 9, 1931.
[4] R. Willstätter and A. Pollinger, *Z. physiol. Chem.*, 130: 281, 1923.
[5] K. Zeile and H. Hellstrøm, *Z. physiol. Chem.*, 192: 171, 1930; 195: 39, 1930–31.
[6] R. Kuhn, D. B. Hand and M. Florkin, *Z. physiol. Chem.*, 201: 255, 1931.
[7] R. Willstätter, J. Graser and R. Kuhn, *Z. physiol. Chem.*, 123: 1, 1922.
[8] J. B. Sumner, *Jour. Biol. Chem.*, 69: 435; 70: 97, 1926; J. B. Sumner and D. B. Hand, *Naturwiss.*, 16: 145, 1928.
[9] J. H. Northrop, *Jour. Gen. Phys.*, 13: 739, 1930.
[10] E. Waldschmidt-Leitz and F. Steigerwaldt, *Z. physiol. Chem.*, 195: 260, 1931; 206: 133, 1932.
[11] H. Dyckerhoff and G. Tewes, *Z. physiol. Chem.*, 215: 93, 1933.
[12] E. Waldschmidt-Leitz and E. Kofranyi, *Naturwiss.*, 21: 206, 1933.

enzymes. Only in this way, one may expect to find an explanation for the high specificity of enzymes and for the mechanism of their action.[13]

E. WALDSCHMIDT-LEITZ

PRAGUE

REDWOODS AND FROST

DURING the cold period in the second week of December, 1932, the coast redwood, *Sequoia sempervirens,* was noticeably frosted in the northern part of its range in Del Norte and northern Humboldt Counties, California. The damage was general but not severe and was confined to the new growth on trees in exposed situations and the outer foliage of young trees. The leaves in many instances were browned as if by a fire.

From December 8 to December 15, inclusive, a period of eight days, minimum free air temperatures of from 30° to 22° Fahrenheit were recorded at the Eureka station of the U. S. Weather Bureau. During this time departures from the average daily temperatures ranged from −15° to −18°. The minimum low of 22° occurred on December 12. The only other period of cold which is comparable in intensity and duration was experienced in the winter of 1887–1888 a few years after the establishment of the Eureka Weather Bureau Station. At that time the lowest recorded minimum of 20° was registered, and minima of less than 32° were experienced for seven days. The recent cold spell was characterized by unusually low relative humidity for the place and season; the percentage at noon from the 10th to the 13th varied from 27 to 20. The low humidity probably intensified the effects of the freezing temperatures.

The reaction of the redwoods to the present winter weather throws some light on the question of the seemingly anomalous northern boundary of the redwood belt. The redwoods are manifestly limited at the south by insufficient precipitation and low humidity, but the reason for the location of the northern boundary has not been clear, since there is little difference between the climate of the northwestern coast of California and the southwestern coast of Oregon. The northernmost grove of redwoods, now logged off, consisted of about forty acres of mature trees and was located a few miles north of the California state boundary and about twenty miles inland on an elevated table-land at an altitude of about 2,000 feet. There are scattered mature trees on the high benchlands along Smith River from 20 to 25 miles to the south of this grove at altitudes of from 1,500 to 2,500 feet. The nearest extensive grove is found on the coastal shelf at the mouth of Smith River about 15 miles southwest of the northernmost grove. The Smith River groves are open to the influence of the sea wind at all times. It should be noted that the elevated bench-lands and the coastal shelf are both protected from the formation of the pools of cold, dry air which accumulate during the high pressure conditions in the winter, and are thus naturally frost-protected habitats.

A major part of the reproduction in the established redwood groves is by stump sprouting, but any advance of the species into new territory must be by means of seedlings. It may be that these seedlings are killed during the occasional cold winters in the northern part of the range and that the northern boundary of the redwood belt is defined by the maximum tolerance of the species for frost.

The writer hopes to report later on the effect of the frost on the stump sprouts in the northernmost grove and the reaction of the seedling trees to the present inclement winter weather.

HARRY D. MACGINITIE

STUDIES ON THE BOTTOM FAUNA OF FRESH-WATER LAKES

A VERY interesting and valuable paper discussing the littoral population of western Lake Erie within the six-foot contour appears in the April number of *Ecology.*[1] On page 82 the authors state that no population studies have been made in which the shore is divided into physical areas and depths and the quantitaitve results published in detail. Had the authors delved more deeply into the bibliography of the subject they would have found at least two papers[2] dealing with population problems of the littoral area described in great detail. These cover studies on Oneida Lake, New York, and on Winnebago Lake, Wisconsin. Neither of these lakes have the shelving rock habitat of the shore of Lake Erie, but the other shore habitats, such as boulder, gravel, sand, clay and mud, are present. The populations of these areas per square meter in the two lakes studied are shown below

	Oneida Lake	Winnebago Lake
Boulder bottom	1,945	321
Gravel bottom	1,944	1,579
Sand bottom	3,421	1,326
Clay and mud bottom	5,866	1,450
Vegetation	263	4,400

[13] E. Waldschmidt-Leitz, *Phys. Reviews,* 11: 358, 1931.

[1] "Bottom Shore Fauna of Western Lake Erie," F. H. Krecker and L. Y. Lancaster, *Ecology,* 14: 79–93, 1933.

[2] F. C. Baker, "Productivity of Invertebrate Fish Food on the Bottom of Oneida Lake, with Special Reference to Mollusks," N. Y. State Coll. Forestry, Tech. Pub. 9: 11–233, 1918; "The Fauna of the Lake Winnebago Region," Trans. Wis. Acad. Arts and Sci., 21: 109–146, 1924.

and compare favorably with the studies made in Lake Erie, and in fact show a much larger population per unit area in some cases.

No actual figures of the Lake Erie population are given, but the graph on page 84 shows that few of the areas exceed 1,000 individuals. In Lake Winnebago the greatest number of individuals was found between 2–6 meters in depth and in Oneida Lake between one and two meters. In Lake Erie the maximum population was found in the shallow areas bordering the shores, as has been noted in all lakes studied quantitatively. The vegetation population in Lake Winnebago varies enormously. While the average shows only 4,400 individuals per square meter, there are favorable localities where the population will run as high as 15,000 or 20,000 per square meter, especially in some of the sedge habitats.

It is to be regretted that the unit areas of the Lake Erie paper were not made in square meters instead of square yards, because most studies of this nature have been made with the metric measurements, and while the two units are approximately the same there is still enough difference to make it difficult to compare results accurately.

Lake Winnebago is in many respects similar to Lake Erie in its physical as well as its population make-up. Many species and races of naiades are identical and are found only in these two localities. With the exception of the vegetation areas, the population per square meter is greater in Lake Winnebago than it is in Lake Erie. The population per square yard of the shelving rock shore of Lake Erie is parallelled in the Wabash River at New Harmony, Indiana, Thomas Say's historic collecting locality, where the under side of a flat rock averaging a square foot in area will often be so thickly covered with mollusks (Pleuroceridae and Somatogyrus) that every fraction of an inch is occupied. A count of one such rock gave more than 1,500 individuals. A square meter in several places at this locality will contain in excess of 10,000 mollusks.

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NOMENCLATURE OF THE ELECTRON

DR. ANDERSON'S recent discovery of the positive analog of the long known negative electron has raised an important question of nomenclature. The word electron was originally devoid of significance regarding polarity. But the custom of using it as a specific term for the negative unit has acquired considerable prestige. This custom might continue unchanged if Professor Herbert Dingle's suggestion of "Oreston" as the name of the new positive unit were adopted. The suggestion has considerable merit for that reason as well as because of its mythological significance.

Nevertheless, the writer is inclined to protest against its adoption and to plead for Dr. Anderson's terms "positron" and "negatron." The basis for the plea is simple but nonetheless weighty, to one who is concerned with elementary instruction; namely, that the latter terms are obviously descriptive of the principal properties of the two units. In consequence, the student's learning of terms and definitions would be simplified and brought closer to reality.

The term "electron" may then be used in its original generic meaning, without reference to the specific charge that the particle might have.

E. A. WILDMAN
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SPECIAL CORRESPONDENCE

THE SECOND PSYCHOLOGICAL EXPEDITION TO CENTRAL ASIA

THE second psychological expedition to central Asia which took place in the summer of 1932 had for its aim extension of researches which were undertaken by the first expedition in 1931. The fundamental aim was the study of those peculiarities of the psyche which are the result of various historical conditions and to trace out the fundamental laws in development of psychological processes. In this respect central Asia is of exceptional interest on account of the residuals of primitive economic conditions which are now undergoing tremendous industrial, political and cultural transformation. This change gives opportunity not only for the studying of the peculiarities of psychological processes under various conditions, but also, what is more important, the very dynamics of the transition from the more elementary psychological laws to the more complex processes. Just as in the first expedition the study was undertaken in the region of Uzbekistan, in which were specially chosen the more primitive Kishlaks districts as far as their economic, cultural and social conditions were concerned, such as the Kishlaks of Shahimardan and Jordan and the grazing kirgiz lands in the Altai Mountains, as contrasted with the Kishlaks of Palman with a thorough collectivization, well-developed cultural work and high industrial organization.

In contradistinction to the first expedition not only the adults were studied, but also the Kishlak youth on whom the cultural changes must have made a special impression.

The expedition was organized by the State Psycho-

logical Institute of Moscow, the Psychological Section of the Ukrainian Psychoneurological Academy of Kharkov and the Department of Education of the Uzbek Pedagogical Academy. The expedition was also backed by People's Commissariat of Education of the Uzbek Socialist Soviet Republic and the Government of Uzbekistan.

The immediate aim of the expedition consisted in the further study of the system of thinking which is characteristic of primitive societies, the development of the psychological functions in their thinking and to point out those changes which this thinking undergoes in social and cultural transformation connected with socialistic growth. In the account of the first expedition it was shown that in the primitive community life one finds a specific system of thinking which is characterized by its own structure and by a different rôle which speech takes in it. A fact was noted that the main function of this thinking is not the formation of abstract connection and relationship between symbols, but reproduction of whole situations, whole complexes closely connected with specific life experiences; it was pointed out that separate psychological operations, such as memory, comparison, generalization and abstraction, are formed in this type of thinking quite differently, and that with the change of economic conditions this situational or complicated thinking very quickly becomes changed, giving place to other more complex forms of thought. It was the aim of the second expedition to study in more detail the characteristics of the structure of the "situational" thinking and its various functions as well as a study of those paths along which the transformation of the situational thinking takes place by the development of thought into concepts under the influence of such new molding forces as collectivization, cultural development, literature, etc. In this field the following problems were undertaken:

(1) Professor A. R. Luria, in cooperation with Bagautdinov, "The Structure of Situational Thinking and the Lines of its Modifications."

(2) Professor Kurt Koffka, together with G. Ashrafy, "Investigation of Perception in Various Historical Cultural Phases."

(3) Professor P. Leventueff, together with Assistant Mangushova, "Investigation of Causative Thinking and its Historical Development."

(4) Docent F. H. Shemyakin, together with Assistant Nugmonov, "The Understanding of Symbols in Situational Thinking."

(5) Assistant E. N. Mordkovich, "The Understanding of a Poster and its Meaning in Situational Thinking."

(6) Docent A. A. Ussmanov, together with E. H. Mordkovich, "Operations of Counting in Complex Thinking."

The material obtained in the two psychological expeditions to central Asia established certain peculiarities in the structure of thinking and the special psychological process at various stages of cultural historical development. It outlined those lines along which we have the development of psychological processes in a changing environment largely characterized by ever-increasing economic and industrial complexities. Further work in the analysis of this material, as well as a comparison of experiments in the villages as contrasted with the factory, would go on in a special division devoted, in the Moscow Psychological Institute, to the study of development of the psyche. The control investigation of structure of thinking in the disintegration of psychological processes would be concentrated in the division of normal and pathological psychology of the Psychological Sector of the Ukrainian Psychoneurological Academy in Kharkov. The further work in the study of the development of thought in the Uzbek child would be conducted by the pedagogical faculty of the Uzbek State Pedagogical Academy in Samarkand. The works of the first and second psychological expedition will be ready for press and prepared for publication by Professor Luria within the next year. A more complete account of this expedition is appearing in the forthcoming issues of the *Journal of Genetic Psychology* and the *British Journal of Psychology*.

A. LURIA[1]

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE MEASUREMENT OF SKIN COLOR

THERE is great need for a portable mechanism with which the color of opaque objects may be accurately determined. The writer has been interested for some time in estimation of the color of human skin. Many of the reports in the literature relating to human skin color are those of the students of race and those of the investigators of climatic effects. Irreplaceable data have been collected by these workers through use of mechanisms based upon the principle of the color top (or wheel) or upon comparative color scales of porcelain or paper. Many of these devices have the advantages of simplicity in use and easy portability. They are, however, open to certain criticisms, especially those of the errors possible in any subjective method and those relating to an uncontrolled and variable light source.

The medical literature of the last few years indi-

[1] Translated from Russian by J. Kasanin and F. L. Wells.

cates the need of both clinicians and research investigators for a less subjective yet simple means of estimating skin color. Technical improvements in optical instruments have stimulated the use of photometric and spectroscopic mechanisms by medical investigators interested in cutaneous pigmentation. It is now generally admitted that the combination of photometry and spectroscopy in spectrophotometry provides the fundamental method for measurement of color. Visual spectrophotometry has been found to be too time-consuming. Although photoelectric spectrophotometers will undoubtedly become the standard instruments eventually, such an apparatus is at the present time too expensive and not sufficiently portable for most investigators interested in human skin color.

One characteristic of skin colors is that they are not highly saturated. For this reason, the writer was advised by Professor Arthur C. Hardy, of the Massachusetts Institute of Technology, that a trichromatic colorimeter would serve the writer's needs satisfactorily, would be portable and could be constructed for a relatively moderate sum. Funds were secured from the National Research Council, Medical Division, in the form of a grant-in-aid and such a colorimeter was built at the Massachusetts Institute of Technology under Professor Hardy's direction.

The essential element in this skin colorimeter is a Martens polarization photometer, the eyepiece of which is sufficiently modified to permit the insertion of three color filters. These are respectively:

Red	Wratten A (No. 25)
Green	Wratten B (No. 58)
Blue	Wratten C (No. 49)

An integrating sphere, approximately fifteen centimeters in diameter, is set onto the objective end of the photometer. At the pole of the sphere opposite to the photometer, an aperture thirty-two millimeters in diameter is placed. Four automobile headlight bulbs of six volts each illuminate the concavity of the sphere as well as any object placed at the aperture. The lights may be run with standard electric current using a transformer, but the writer prefers to employ a small automobile storage battery. A snap switch insures against wasting of current and undue heating of the sphere when the instrument is not actually in use. The instrument is about thirty-three centimeters long and weighs less than two kilograms. It is easily portable in a wooden case.

In operating the colorimeter to obtain a skin color reading, the instrument is first calibrated for each filter by placing the window of the sphere over a freshly scraped piece of magnesium carbonate (obtainable at most drug stores), balancing the brightness of the two halves of the photometric field, and recording the scale reading. Next, the aperture of the colorimeter is set against the skin, and readings are again taken through each of the filters.[1] The reflecting power of the skin relative to that of the standard white magnesium carbonate is then determined for each filter by calculating the ratio of the tangent squared of the angle read on the skin to the tangent squared of the angle read on the magnesium carbonate.

Using a recording spectrophotometer, Professor Hardy determined for each of the three filters of the colorimeter the respective spectrophotometric curves showing the transmission of these filters as a function of wave-length. This was done in order that the data obtained with this particular colorimeter can be transformed subsequently into any terms that may seem desirable. The state of color science at the present time does not justify an attempt to do this and hence these curves are merely for record purposes, to be used if a standard method of color specifications becomes universally adopted.

The colorimeter as above described is now being used by the writer. It is easy to use, and check readings are consistent. Data obtained through use of this colorimeter will soon be ready for publication.

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PREPARING QUICK-DRYING CANADA BALSAM

CANADA balsam is undoubtedly the most universal medium used for the mounting of slides in microscopy. However, one of the most serious objections to it is the time required for hardening. In biological work the slides must be kept in a horizontal position for several days, while in petrographical work the solid stick balsam necessitates a heating of the thin rock slices in order to receive the cover slips. In both cases the degree of inconvenience could be lessened by using a type of liquid balsam which hardens relatively rapidly.

In the making of thin sections of rocks, after following the usual procedure[1] of grinding to thinness (0.02–0.03 mm), the real hazard comes in mounting the cover glass. The disadvantages of the hot mounting method are: the formation of bubbles under the rock slice, the formation of bubbles under the cover glass, breaking of friable sections by pressing on the

[1] Due to the fact that skin colors are not highly saturated, the color difference in the two halves of the field is ordinarily small and readings are but little affected by anomalies in the observer's visual mechanism.

[1] A. Johannsen, "Manual of Petrographic Methods," p. 595, 1918.

cover glass, breaking of the cover glass, and unless the consistency is just right there is difficulty in pressing down the cover glass evenly, frequently necessitating reheating. The advantage of the hot method is the quick cooling allowing immediate use of the section. The cold mounting method obviates all the disadvantages of hot mounting but requires several days for the balsam to dry. This disadvantage has been overcome by the use of a specially prepared liquid Canada balsam.

The preparation is rather simple and involves no unusual materials. Heat the liquid balsam in an evaporating dish slowly (for several hours) until it has a decided orange color and test for brittleness by placing a few drops in cold water. The balsam should be very brittle when cold. Then pour the molten balsam in cardboard boxes and let stand till cold. When it has hardened break away the cardboard and shave the block of balsam with a razor blade or powder it, then dissolve in a small quantity of xylol. Enough balsam should be added to thoroughly saturate the xylol, and the solution should have the consistency of thick honey. Place in the usual Canada balsam bottle, with the ground glass cover, and it is ready for use. If properly prepared, the solution should harden sufficiently in a few hours to render slides usable. By allowing to set overnight the slides can be safely filed in a vertical position, with no fear of the cover glasses moving.

In petrographic practice this method of cold mounting has proven successful and even after a year's time no ill effects have been noticed in the mounts. It is probable that the use of a liquid balsam which will harden overnight will be of as much value to biological microscopic technique as it is in petrographic methods.

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SPECIAL ARTICLES

BACTERIA AS FOOD FOR VERTEBRATES

THE rôle that bacteria directly play in the food supply of the higher forms of animal life, particularly the vertebrates, is not definitely known. That they serve as an important source of food supply to some of the protozoa has been well established experimentally. There is some evidence that bacterial cells can be utilized as food by some of the many-celled invertebrates. The latest evidence is that presented by MacGinitie, who has demonstrated that certain marine worms can utilize a species of Pseudomonas as food.[1] His report does not indicate that the worm can subsist exclusively on a diet of Pseudomonas. Bottom-feeding vertebrates, such as the tadpole, whose mouth parts have a mopping up effect on the bottom, and even such fishes as the sucker, carp, etc., which feed on organic matter on the bottom undoubtedly ingest great numbers of bacteria. The experiments described in this paper were designed to determine whether such bacteria are utilized as food.

In April, 1932, the freshly deposited eggs of *Rana pretiosa* and *Hyla regilla* were gathered. These soon hatched and served as a supply of tadpoles of the two species. They were kept in pans containing water plants of various kinds.

A few preliminary experiments demonstrated that the larval forms of *Hyla regilla* were much more sensitive than those of *Rana pretiosa* to factors other than the food supply and consequently were abandoned as the experimental animal. Both forms died when the bacterial flora became too concentrated, but the larval form of *Rana pretiosa* resisted this condition better. No attempt was made to determine whether death resulted from the reduced oxygen content or from toxic products produced by the bacteria. The animals in one flask died after receiving the bacterial washings from slants several days old.

The procedure adopted after the preliminary experiments was as follows: The tadpoles were placed in 50 cc tap water in 1,000 cc flasks. A 24-hour mixed culture of bacteria taken from the pans containing the stock of tadpoles served as the food supply. The water in the flasks was changed daily or oftener. Some fatalities occurred when too heavy a suspension of bacteria was placed in the flasks. Part of the time a heavy suspension of bacteria was placed in a flask and the tadpoles permitted to feed during the day when they could be watched. At evening they were placed in fresh bacteria-free water and thus were without food during the night. Successful results were obtained by using the bacteria washed from two to three potato extract agar slants as the daily food supply of 4 to 6 tadpoles. The amount of food needed and the concentration of bacteria resisted varied somewhat with the size of the animals. The tadpoles could be seen feeding on the bacteria as these settled on the glass. The turbidity of the suspension cleared as the feeding progressed. In some of the flasks there was sufficient organic matter introduced with the bacteria for bacterial multiplication. When too many bacteria were present, either as the result of being introduced or multiplying, the tadpoles did not thrive.

The first series of flasks were started on April 26, 1932. One flask received only tap water and served

[1] G. E. MacGinitie, "The Rôle of Bacteria as Food for Bottom Animals," SCIENCE, 76: 490, 1932.

as the control. The second flask received the bacteria washed from the surface of agar slants.

The control animals were soon found to be smaller in size and darker in color than the experimental animals. Their fecal matter was less in volume and darker in color. All were dead of starvation in 15 days.

The experimental animals appeared to thrive as well or better than in the stock pans. At the end of the 9th week when in the two-legged stage all died suddenly. The cause of death is unknown, but it was evidently not due to lack of a proper diet. The animals had flourished for nine weeks and died too suddenly.

The second series of animals were taken from the stock pans on June 22. These animals were approximately three months old, about two months older than the first series but from the same batch of eggs. The animals were placed in four flasks. One flask served as the control, receiving nothing but tap water. A second flask received bacteria washed from the surface of two or three standard agar slants. A third flask received similar bacteria washed three times in tap water to remove all organic matter that came from the agar slants. A fourth flask received six to ten drops of potato extract broth and no bacteria.

The tadpoles in the first flask of the second series died of starvation within 20 days. The animals in the second flask developed normally within two months to the four-legged tailless stage and were then preserved in formalin.

The animals in the third flask, feeding on bacteria free of all extraneous organic matter, did not at first thrive as well as those in the second flask. Since some bacteria were lost during the washing process it was thought this might be due to the smaller quantity of food received. The volume of washed bacteria given was increased with the result that the animals began to grow more rapidly and completed a normal metamorphosis into the tailless stage within three months. They were then killed, and preserved in formalin.

The animals in the flask receiving only sterile broth were able to live and grow slowly. Bacterial growth occurred in the flask after the small amount of broth was added. It appears probable that the growth was determined solely by the bacteria developing and not by the other organic matter present. Several of the animals died, but one reached the four-legged stage at the end of the fifth month.

DISCUSSION

The experiments described demonstrate that bacteria serve as a satisfactory food supply for the larval stages of the frog *Rana pretiosa*. Apparently water bacteria contain all the food factors necessary for the metamorphosis of this animal. The animals developed as fast or faster than did the controls in a laboratory environment containing various kinds of water plants. The development of the animals in their natural environment in the streams and ponds was not checked with the growth in the laboratory. A casual examination of the streams seemed to indicate a more rapid development than in the laboratory. Factors other than food were involved.

I am not aware that the larval frog requires vitamins in its food. If it does, then the bacteria used contain them in sufficient quantity for development of the tadpole to the frog stage. The study of vitamin production by bacteria has just begun. It has been shown that vitamins A and B are produced by some but not by all bacteria.[2] In this laboratory we have shown (unpublished data) that *Bacillus acidophilus* does not produce vitamin B in fermented milk. Apparently the occurrence of vitamins in bacteria will be found to be as irregularly distributed as in the higher plants.

In experiments to determine the value of bacteria as food for the higher animals the possibility of one-celled animals interfering by feeding on the bacteria and in turn serving as a source of food must be considered. Apparently protozoa did not multiply in our flasks and affect the results.

CONCLUSIONS

Common water bacteria contain all the food factors, including vitamins, necessary for the normal development of the larval stage of the frog *Rana pretiosa*. Since the larval frog can utilize bacteria as food we should expect to find a wide variety of both invertebrates and vertebrates taking advantage of this source of food supply. Bacteria serve as a direct as well as an indirect factor in determining the food supply of the higher animals.

VICTOR BURKE

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LOCALIZATION OF SPIROCHETA PALLIDA IN THE BRAINS OF RABBITS FOLLOWING INTRASPINAL INJECTION OF TESTICULAR TISSUE AND PHYSIOLOGICAL SALT SOLUTION

THE experimental study of neurosyphilis is seriously hampered by the fact that we do not possess a suitable laboratory animal for experimentation. It is an interesting fact that the rabbit, so admirably suited for the study of other manifestations of syphilis, is, generally speaking, incapable of harboring a syphilitic infection of the central nervous system. In spite of persistent efforts of numerous investigators, it has been so far possible to detect the presence of spirochetes in the

[2] C. E. Skinner and M. F. Gunderson, "Production of Vitamin A by a Species of Corynebacterium," *Jour. Biol. Chem.*, xcvii, 53: 1932.

central nervous system of syphilitic rabbits only in a few isolated instances. A new approach to the problem was indicated by the discovery of Kolle and Schlossberger[1,2] of the asymptomatic syphilitic infection of mice and rats. These investigators showed that mice and rats infected with pieces of chancre tissue of syphilitic rabbits, were capable of harboring an asymptomatic infection which could be demonstrated by injection of emulsions of their internal organs, including the brain, into normal rabbits, which thereupon developed syphilitic lesions. It was further shown by Schlossberger[3] that spirochetes which have thus passed through the brain of rats or mice acquired the unusual property of being able to penetrate into the brain of rabbits, a property which is maintained through successive passages from rabbit to rabbit. In these experiments and similar experiments of the authors,[4,5] it became possible for the first time to cause the *Spirocheta pallida* to penetrate into the brain of rabbits in a large number of cases.

The affinity of the *Spirocheta pallida* for testicular tissue, as shown, for example, by the experiments of the authors[6,7] in which spirochetes, introduced intraspinally into rabbits, quickly disappeared from the cerebrospinal system and localized in the testicles, suggested an interesting possibility in connection with the so-called Reynals factor. It was shown by Duran-Reynals[8,9] and Hoffman and Duran-Reynals[10] that extracts of certain organs (testicles, kidney, brain and skin) have an enhancing action on the development of vaccine virus and staphylococcus infection and that testicular extract is by far the most active. It was further shown that testicular extract of the rabbit caused injected India ink and Prussian blue to spread much more extensively through the intercellular spaces than was the case when suspensions of Ringer's solution only were used. It is possible that the enhancing power of the testicular extract is accompanied by an effect which consists in rendering the cells more easily penetrable by the injected agents.

It now appeared promising to the authors to attempt to render the central nervous system of the rabbit more easily penetrable to spirochetes by injection of normal testicular extract. This was, in fact, done in a series of experiments of which the present article is a preliminary report. Six rabbits received an intraspinal injection of an emulsion of testicular tissue of normal rabbits. Shortly thereafter they were inoculated, 3 intratesticularly and 3 intravenously, by the usual method with syphilitic testicular tissue (Nichols strain). Six to seven weeks later testicular lesions appeared, and when the brains of the animals were removed and emulsions prepared from them were injected into testicles of normal rabbits, positive results (lesions containing numerous active spirochetes) were obtained in all the six animals. The situation, however, was complicated by the somewhat unexpected fact that a positive result was also obtained with one animal injected intraspinally with physiological salt solution. This renders the interpretation of the results obtained somewhat uncertain. In order to determine whether the effect may not possibly be due to the traumatic shock of the injection, experiments are now in progress in which distilled water and also a number of other substances are being injected intraspinally.

The net result, so far, is that spirochetes may be induced to penetrate into the central nervous system of rabbits with the aid of an intraspinal injection of normal testicular tissue, or (in one case) physiological salt solution.

In conclusion, we take pleasure in acknowledging a very stimulating discussion with Dr. Duran-Reynals which gave the immediate impetus to the experiments here reported.

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[2] W. Kolle and H. Schlossberger, "Die Persistenz der Syphilisspirochäte in Mäusen, während langer Zeitraume," *Deut. med. Wochnschr.*, 54: 129, 1928.

[3] H. Schlossberger, "Experimentelle Untersuchungen über das Eindringen der Syphilisspirochäten in das Zentralnervensystem von Mäusen und Kaninchen," Arb. a. d. Staats-Inst. f. exper. Therap., No. 21, p. 344, 1928.

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[5] G. W. Raiziss and M. Severac, "Asymptomatic Syphilis," *Arch. Dermat. and Syph.*, 27: 923, 1933.

[6] G. W. Raiziss and M. Severac, "Testicular Lesions in Rabbits Following Intraspinal Syphilitic Infection," *Proc. Soc. Exp. Biol. and Med.*, 24: 756, 1927.

[7] G. W. Raiziss and M. Severac, "Chemotherapeutic Studies Concerning the Penetration of Organic Compounds of Arsenic into the Cerebrospinal System," *Arch. Dermat. and Syph.*, 22: 1031, 1930.

[8] F. Duran-Reynals, *Compt. rend. Soc. biol.*, 99: 6, 1928.

[9] F. Duran-Reynals, *Jour. Exp. Med.*, 50: 327, 1929.

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